

# Detecting Radiation on the Move

**TERRORISTS** beware. If you're considering bringing material for a "dirty bomb" into the U.S., a new Livermore technology can almost literally stop you in your tracks. Try hauling radiological material over the border in a fast-moving truck, and the adaptable radiation area monitor (ARAM) will be able to detect it. ARAM detectors, which have already been installed at many border crossings, are designed specifically for fast, accurate detection without interrupting the flow of traffic and commerce.



The adaptable radiation area monitor (ARAM) can detect small amounts of radioactive material hidden in a vehicle moving at highway speeds.

The ARAM technology won a 2005 R&D 100 Award, which Livermore scientists, led by physicist Dan Archer, share with Innovative Survivability Technologies (IST) of Goleta, California. IST licensed the technology in January 2004.

"The ARAM system can serve as a stand-alone radiation monitor, or it can be networked into a system of monitors to cover a large area," says Archer. In addition, the system can be used as a fixed detector to monitor slow-moving packages, luggage, or pedestrians and as a portable detector. ARAM is optimized to detect even small quantities of radioactive materials moving at highway speeds. This capability makes ARAM a crucial element in the effort to protect the nation from radiological weapons of mass destruction.

## Improving Time Resolution

ARAM is an automatic, highly sensitive system that uses a thallium-doped sodium iodide crystal to detect even small amounts of radiation in different scenarios. The crystal may be shielded on as many as four sides to "point" the detector in a particular direction, or it may not be shielded at all. The crystal detects full spectral data by dividing the spectrum into 1,024 energy bins, or channels. It counts single photons, unlike most other detectors, which collect gross counts or divide the spectrum into only 10 channels. ARAM's method, known as list mode, produces large quantities of raw, time-stamped data that can be analyzed in any number of ways. List mode increases overall sensitivity and the signal-to-noise ratio for spectral data analysis, thereby increasing the probability of a proper identification. This feature is particularly important for detecting radioactive materials hidden inside moving vehicles.

"ARAM is unique because it combines shielding, a large crystal, and the very brief time during which the radiation source needs to be in front of the detector," says Archer. "ARAM can achieve the highest signal-to-noise ratio to date among comparable detector systems."

The software for the ARAM system provides near-real-time results. With Ethernet connectivity standard on all units, ARAM can be interfaced to a variety of radiation detector technologies. Third-party detector systems can be connected for data archiving and processing. Digital cameras may be attached to further document events, and multiple annunciation mechanisms are available, including e-mail, local paging, liquid crystal displays, and Ethernet-attached annunciators. Radiation levels and spectra are archived by the software and made available via the Web (and secure Web transmission) for remote telemetry and viewing.

By acquiring data in list mode, ARAM can produce output with much finer time resolution than similar programs. Fine time resolution offers numerous advantages: Small sources of radiation moving at highway speeds can be detected and identified, and the



direction of the radiation source's motion may be determined. Fine time resolution also protects the source spectrum from contamination by background radiation collected immediately before or after an event. Eliminating this spectral contamination results in better data for radionuclide identification.

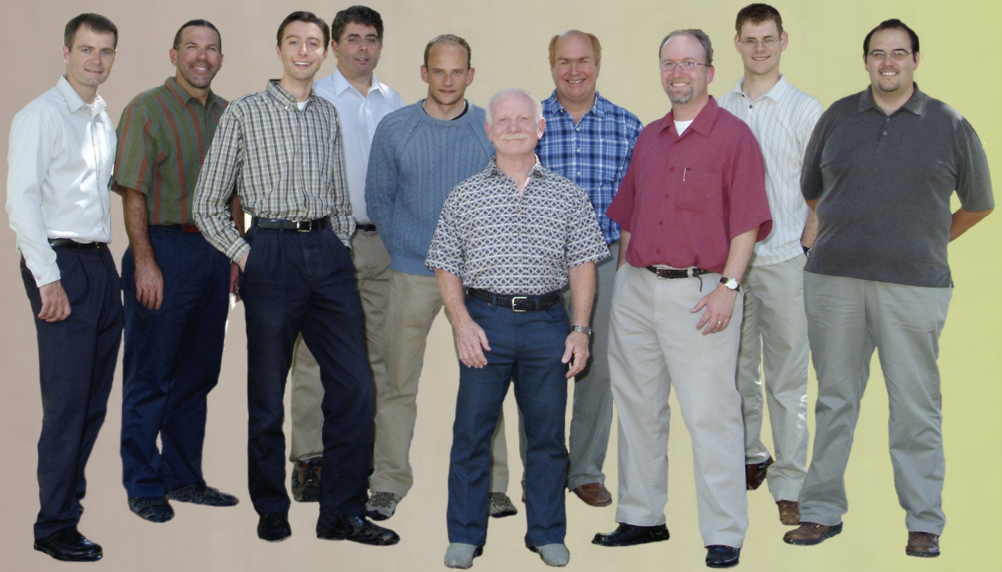
When a spectral anomaly is detected, "trigger" algorithms operate on the acquired data and produce detailed, easily read event reports. These advanced algorithms include enhancements to improve performance in difficult scenarios, such as roadside monitoring, and to substantially reduce false alarms—for example, when the shielding effect from a large truck causes a change in the level of background radiation.

### No Choke Point to Slow Traffic

Monitoring for radiological material involves three steps: detection, localization, and identification. Each step could require a different piece of equipment, depending on a system's design. For example, in some systems, a large portal monitor might perform the initial detection phase of all vehicles. Suspect shipments would then be inspected using smaller handheld detectors to localize and identify the material. The ARAM design combines detection and identification into a single step.

Comparing ARAM to other commercially available radiation monitors is difficult. Many systems have been designed to detect small quantities of smuggled nuclear materials leaving nuclear plants. Detectors also monitor scrap metal entering steel mills to avoid contaminating the mills, because hiding nuclear material in scrap steel is a common disposal method. Several of these detectors indicate the presence of radiation but provide little identification capability. The nuclear fingerprint that ARAM's system supplies reduces the need for secondary screening. Thus, ARAM minimizes the number of labor-intensive inspections on suspect shipments and keeps commerce moving. In addition, many radiation monitors require people and material to pass through a narrow detection area, which becomes a choke point that slows traffic. In contrast, ARAM can operate in a pass-by mode so traffic continues to move freely.

ARAM's adaptability has been thoroughly tested. ARAM was used as a fixed device to monitor packages for Federal Express in its air-cargo facility at the Denver International Airport. Another version of ARAM was integrated into a vehicle, in which the operator could perform his or her normal job and be able to monitor for radioactive materials. In this configuration, ARAM can operate like a portal



Members of the ARAM development team: (left to right) David Pletcher, Mike Mercer, Brock Beauchamp, David Trombino, Vincent Riot, Tom Schaffer, Joe Mauger, Daniel Archer, Karl Nelson, and Guy Urbina.

monitor that can be moved from site to site, or it can be used in a mobile mode, testing for radiation anomalies while the vehicle is in motion. Yet another version of ARAM was part of a demonstration in which 14 independent systems were networked to detect and identify multiple radiation sources of varying strengths.

California is the first state to install radiation detection units such as ARAM at border crossings, and other states have expressed interest in the technology. According to IST, a major port authority has proposed integrating more than a dozen ARAM units into a system to monitor people at marinas and a ferry terminal. With ARAM around, people and vehicles carrying illicit radiological material can run, but they can't hide.

—Katie Walter

**Key Words:** adaptable radiation area monitor (ARAM), homeland security, radiation detection, R&D 100 Award.

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